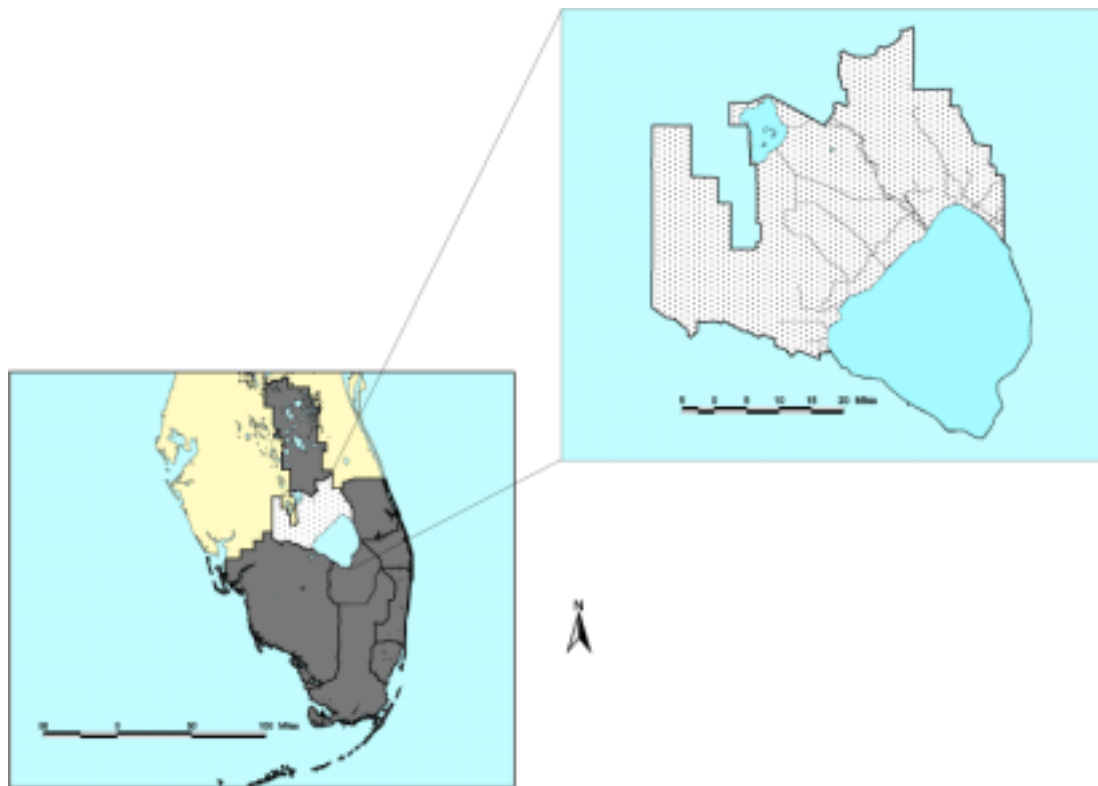


## Chapter 4

# LAKE OKEECHOBEE WATERSHED REGION

### PHYSICAL CONDITIONS - LAKE OKEECHOBEE WATERSHED REGION

Lake Okeechobee lies 30 miles west from the Atlantic coast and 60 miles east from the Gulf of Mexico in the central part of the peninsula. Lake Okeechobee is a broad shallow lake occurring as a bedrock depression (**Figure 3**). The large, roughly circular lake, with a surface area of approximately 730 square miles, is the principal natural reservoir in southern Florida.



**Figure 3.** Lake Okeechobee Watershed Region.

The lake's largest outlets include the St. Lucie Canal eastward to the Atlantic Ocean and the Caloosahatchee Canal and River to the Gulf of Mexico. The four major agricultural canals – the West Palm Beach, Hillsboro, North New River and Miami canals - have a smaller capacity, but are used whenever possible to release excess water to the Water Conservation Areas (WCAs), south of the lake, when storage and discharge capacity are available. When regulatory releases from the lake are required, excess water

can be passed to the three WCAs up to the capacity of the pumping stations and agricultural canals, with the remainder going to the Atlantic Ocean and Gulf of Mexico.

The waters of the lake are impounded by a system of encircling levees, which form a multi-purpose reservoir for navigation, water supply, flood control and recreation. Pumping stations and control structures in the levee along Lake Okeechobee are designed to move water either into or out of the lake as needed.

Other surface water bodies include the Kissimmee River, Fisheating Creek and Taylor Creek that flow into the lake from the north; the Caloosahatchee River that flows out of the lake to the west; the St. Lucie and West Palm Beach canals that flow out of the lake to the east; and the Hillsboro, North New River and Miami canals that flow out of the lake to the south. The hydroperiod of the lake is partially controlled, permitting water levels to fluctuate with flood and drought conditions and the demand for water supply.

## **EXISTING CONDITIONS - LAKE OKEECHOBEE WATER MANAGEMENT**

Historically, water levels in Lake Okeechobee were probably much higher than they are today (Brooks, 1974), perhaps as high as 6.1 meters (20 feet) NGVD (National Geodetic Vertical Datum). Prior to large scale development and construction of the Herbert Hoover Dike, the lake had no channeled outflows and water overflowed the lake as sheet flow to the south and east. This resulted in a much larger and broader littoral zone and marsh ecosystem to the north and west than the existing one. Today, as the primary reservoir of the Central and Southern Florida Flood Control Project, Lake Okeechobee is capable of storing 2.7 million acre-feet of water between stages of 3.2 meters (10.5 feet) above msl and the top of the regulation schedule at 5.3 meters (17.5 feet) above msl.

Water levels in the lake are managed according to a regulation schedule developed by the South Florida Water Management District (SFWMD or District) and the United States Army Corps of Engineers (USACE). The schedule is designed to maintain a low level of 4.7 meters (15.5 feet) during the wet season in order to provide storage capacity for excessive amounts of rainfall and to prevent flooding in surrounding areas. The stage at the end of the wet season is regulated at a maximum of 5.3 meters (17.5 feet) in order to store water for the dry season. The Caloosahatchee and St. Lucie canals are the primary outlets for release of flood waters when the lake is above regulation stages.

A series of structures are situated around the lake, which provide flood protection, control drainage and facilitate navigation. The USACE operates the primary structures and navigation locks around the lake and is responsible for maintenance of the schedule. The SFWMD operates and maintains the secondary water control structures and pump stations.

Historically Lake Okeechobee's regulation schedule was developed primarily to meet flood control and water supply objectives, the primary purposes for construction of the C&SF Project. The environmental concerns for the lake's littoral zone and wildlife

habitat and the downstream estuaries have generally been compromised in order to meet the water supply needs of South Florida.

Trimble and Marban (1988) performed an analysis of the Lake Okeechobee regulation schedule, which incorporated a trade off analysis framework and resulted in the recommendation of a schedule known as “Run 25.” This schedule reduced the water quality impacts associated with regulatory discharges to the St. Lucie and Caloosahatchee estuaries by reducing the need to discharge large volumes of freshwater from the lake, without significantly impacting existing flood control, water supply and environmental benefits. Run 25 was approved by the District's Governing Board in December 1991 and approved on a two year interim basis by the USACE in May of 1992. A new regulation schedule for the lake was formally adopted by USACE in July 2000. This water supply and environmental (WSE) schedule uses climate forecasting to determine the volumes of water to release from the lake under flood control circumstances, and has the potential to provide environmental benefits for the lake and downstream systems, while not sacrificing water supply. The extent of the benefits will depend in part on specific adaptive management protocols that are presently being developed by the District.

The enactment of the Lake Okeechobee Protection Act (LOPA) (Section 373.4595, Florida Statutes) in 2000 also advanced restoration efforts. This act provides an umbrella that captures many lake restoration efforts. It will significantly enhance mandates restoring and protecting the lake using a phased, watershed-based approach to reduce phosphorus loading to the lake and downstream receiving waters. Fulfilling this act will require a great deal of cooperation among government agencies and the public. To facilitate the execution of the Lake Okeechobee Protection Plan, an interagency committee was formed with individuals from the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (FDACS) and the SFWMD. The agencies are currently planning and implementing numerous management activities in the watershed to reduce phosphorus loading to the lake. These include: the construction of surface water storage reservoirs and stormwater treatment areas; the restoration of isolated wetlands; the development and implementation of best management practices to control nonpoint sources of pollution; the continuation of research and monitoring to ensure projects are designed and implemented to optimize success; the removal of phosphorus-rich sediment from tributaries to Lake Okeechobee; and the implementation of a sediment management feasibility study to determine whether or not it is feasible to reduce internal loading from the lake sediments. More current information regarding the status of the LOPA activities can be found in the *Lake Okeechobee Protection Program Annual Report to the Legislature* (SFWMD, 2001a, 2001b).

## **Water Quality**

Lake Okeechobee may be considered a naturally eutrophic water body that is tending to become hypereutrophic, due primarily from nutrient inputs from the Kissimmee River and the Taylor Creek basins. Water quality conditions in the upper Chain of Lakes area appear to be improving, primarily due to rerouting of wastewater flows from the river

to reuse and ground-water discharge sites. However, large quantities of nutrients are still discharged from Lake Toho to Lake Kissimmee and other downstream receiving waters. Water quality improves from Lake Kissimmee to near Lake Okeechobee, where the channel flows mostly through unimproved rangeland; however, pollutant loadings increase as cattle and dairies grow more numerous near the lake. Because the lake's phosphorus is internally recycled and a vast reservoir of the nutrient is stored in groundwater, as well as wetland and canal sediments, phosphorus within the lake may not reach acceptable levels for many decades or even a century.

According to the 1996 305(b) report (FDEP, 1996) for Lake Okeechobee, the major pollution sources for the lake include runoff from ranch and dairy operations in the north where pollution has elevated phosphorus and coliform bacteria concentrations. In the south, historic backpumping of runoff from row crops and sugarcane has elevated nutrient and pesticide levels. The backpumping has mostly ceased but still occurs when water in the primary canal of the Everglades Agricultural Area (EAA) reaches 13 feet (flood-control levels). As a result, depending on location and seasonal rainfall or drought, the lake receives varying amounts of nutrients, substances creating high biological oxygen demand (BOD), bacteria and toxic materials. Other pollutants include high levels of total dissolved solids, unionized ammonia, chloride, color and dissolved organic chemicals.

Biological sampling indicated variable but generally eutrophic conditions. In recent years, several widespread algal blooms (one covering about 100 square miles) and at least one major fish kill (all of which were widely publicized) launched the environmental community and governmental agencies into intense investigation and analysis of the lake's problems. The Lake Okeechobee Technical Advisory Committee, formed to assess the situation and recommend solutions, determined that phosphorus from dairies and agriculture was a major cause of the noxious algal blooms and that levels should be reduced by 40 percent. A few others contended that the secondary cause of increased phosphorus is the flooding of hundreds of acres of perimeter wetlands after the SFWMD decided in the late 1970's to raise the lake's water level. The higher level also reduced valuable fish-spawning grounds and waterfowl feeding and nesting habitat.

The 1997 and 2002 Surface Water Improvement and Management (SWIM) plan updates reported that phosphorus load reductions had occurred, but the 40 percent reduction in loads was not achieved. It recommended the implementation of programs and projects to improve the lake and watershed water quality situation. Even with the implementation of these programs and projects, nutrient loads to Lake Okeechobee have not decreased significantly. The highest inflow phosphorus concentrations continue to be found in the S-154 and S-191 basins where dairies are abundant and the majority of the out-of-compliance Works of the District (WOD) sites are found. Phosphorus loading is far in excess of the amount considered for a healthy Lake Okeechobee ecosystem and current model data predict that it may take decades before in-lake phosphorus concentrations will respond to reduced external loads.

The federal Clean Water Act (Title 33, Chapter 26, Subchapter III, Section 1313(d)), requires that each state develop total maximum daily loads (TMDLs) for each water-quality-limited segment reported. A TMDL reflects the total pollutant loading, from

all contributing sources, that a water segment can receive without exceeding its capacity to assimilate the pollutant loads and still meet applicable water quality standards. The phosphorus TMDL established for Lake Okeechobee is 140 metric tons (based on a 5-year rolling average) to achieve an in-lake target phosphorus concentration of 40 parts per billion in the pelagic zone of the lake (FDEP, 2000). The restoration target was determined using computer models developed based on past research performed by the SFWMD using SWIM funds. This target will support a healthy lake system, restore the designated uses of Lake Okeechobee, and allow the lake to meet applicable water quality standards.

## **FUTURE WITHOUT PLAN CONDITION - WATER QUALITY - LAKE OKEECHOBEE**

Several watershed and in-lake cleanup projects are currently proposed. These include flow diversion projects for four chapter 298 water control districts established under Florida Statutes (F.S.), diversion of flows from the 715 Farms area, and a critical project authorized pursuant to Section 528 of the Water Resources Development Act of 1996 – the Lake Okeechobee Water Retention/Phosphorus Removal Critical Project) to incrementally reduce inputs of nutrients to the lake. However, to sustain water quality improvements brought about by in-lake cleanup projects, pollutant source reduction programs, via agricultural land acquisition, and implementation of best management practices (BMPs) in the lake watershed must be implemented concurrently. The FDEP, is at present, developing a Total Daily Maximum Load (TMDL) pollutant loading program, which is expected to result in additional pollutant load reduction activities in watersheds flowing to Lake Okeechobee.

## **FUTURE WITHOUT PLAN CONDITION - PHYSICAL FACILITIES AND OPERATIONS - MANATEE PROTECTION**

The West Indian manatee (*Trichechus manatus*) is listed as a federally endangered species and is one of the most endangered species in Florida. As a response to recent manatee mortality trends associated with water control structures, this project will provide operational changes and implement the installation of a manatee protection system at seven sector gates at navigational locks near Lake Okeechobee. The beneficial outcome of this project will be the reduction of risk, injury and mortality of the manatee. The seven sector gates include S-193 at Okeechobee and S-310 at Clewiston on Lake Okeechobee; St. Lucie Lock and Port Mayaca Lock on the St. Lucie Canal; and Moore Haven Lock, Ortona Lock and W. P. Franklin Lock on the Caloosahatchee River. The mechanism proposed would use hydroacoustic and pressure sensitive devices that will immediately stop the gates when an object is detected between the closing gates. These systems will transmit an alarm and signal to stop the gate movement when a manatee is detected. When an object or manatee activates the gate sensors, the gate will stop and open approximately six inches to release a manatee. As a result, a manatee will be able to travel between the open gates. After the gate opens, the operator can fully close the gate unless an object remains between the gates. Then the opening process will repeat the cycle as the sensors

are activated again. Due to these structural modifications, manatees will be at a significantly less risk as they encounter locks with a sector gate. The future without plan condition assumes that the automatic gate sensor devices are installed on these lock sector gates.

## **FUTURE WITHOUT PLAN CONDITION - PHYSICAL FACILITIES AND OPERATIONS - LAKE OKEECHOBEE REGULATION SCHEDULE**

Lake Okeechobee has undergone numerous changes since the initial construction of Herbert Hoover Dike. Today, the Lake Okeechobee's water level is managed to provide a range of desired purposes including, flood protection, water supply and environmental protection using "regulation schedules." In 1995, the SFWMD requested the USACE to study a range of regulation schedules intended to be more responsive to lake ecosystem, down stream users and receiving water bodies. Those studies are currently underway. Due to the uncertainty of the recommendation that will result from that study, the Restudy assumed the current schedule, known as Run 25, for hydrologic modeling of the future without plan condition.

## **FUTURE WITHOUT PLAN CONDITION - PHYSICAL FACILITIES AND OPERATIONS - CRITICAL RESTORATION PROJECTS**

### **Lake Okeechobee Water Retention / Phosphorus Removal**

The project consists of design and construction of stormwater treatment areas (STAs) in the Taylor Creek Basin (200 acres) and in the Nubbin Slough Basin (1,100 acres) and the restoration of isolated wetland sites on ten agricultural parcels in the Okeechobee watershed. The purpose of the project is to capture and attenuate peak flows from portions of the watershed and to improve water quality. The total project cost is estimated to be \$16.3 million according to the project cooperation agreement entered into by the SFWMD and the USACE on January 7, 2000. More information is available regarding this critical project at [www.saj.usace.army.mil/projects/index.html](http://www.saj.usace.army.mil/projects/index.html).

## **WATER QUALITY PROBLEMS AND OPPORTUNITIES - LAKE OKEECHOBEE**

Lake Okeechobee is a Class I water body (potable water supply) according to Florida Administrative Code (F.A.C.) rule. Class I water bodies generally have the most stringent surface water quality and pollution control criteria in Florida. However, water quality data for Lake Okeechobee indicate that the lake is in a eutrophic condition, primarily due to excessive nutrient loads from agricultural sources both north and south of the lake.

The main tributary to Lake Okeechobee is the Kissimmee River. As stated above, several water bodies within the Kissimmee River Watershed, including segments of the river itself, are impaired to various levels. Degradation of water quality in the Kissimmee River Watershed contributes to downstream degradation in Lake Okeechobee. Lower reaches of the Kissimmee River contribute high levels of nutrient loading to Lake Okeechobee.

Another important tributary to the lake is the Taylor Creek/Nubbin Slough Basin. The Taylor Creek/Nubbin Slough Basin contributes high levels of nutrient loading, low levels of DO and elevated coliform bacteria and turbidity levels to the lake. The Taylor Creek/Nubbin Slough Basin contributes only 4 percent of the total volume of inflows to Lake Okeechobee, but accounts for approximately 29 percent of the total phosphorus inflow loads.

Eight segments of Lake Okeechobee are also included on the Section 303(d) list. Water quality parameters/criteria causing impairment at eight different monitoring locations in Lake Okeechobee include: excessive nutrients, low levels of DO and high concentrations of unionized ammonia, iron, chlorides and coliform bacteria. The Fisheating Creek and C-41 basins on the northwest side of the lake also contribute pollutants, causing impairment in Lake Okeechobee.

Water quality in Lake Okeechobee is expected to slowly improve between 1999 and 2050. Field and laboratory studies of phosphorus stored in lake sediments indicate that sediment bound phosphorus is a dominant pollutant affecting lake water quality (Reddy et al., 1995). Currently, the average cumulative phosphorus load to the lake exceeds the Surface Water Improvement and Management Plan target by approximately 100 tons per year (SFWMD, 1997f). Phosphorus loads to the lake eventually become sequestered in lake sediments. The phosphorus in these sediments, which has accumulated over time from excessive external loads, is frequently resuspended (primarily by wind-aided mixing; Havens, 1997) and will tend to maintain a high phosphorus concentration in the water column, even if all sources of phosphorus in the contributing watershed are controlled consistent with regulatory and watershed management programs. Although short-term water quality conditions in Lake Okeechobee are not expected to improve, in place pollutant reduction programs in the lower Kissimmee River and Taylor Creek/Nubbin Slough basins are expected to result in long-term reduction in Lake Okeechobee water column nutrient concentrations.

Urban development in the Lake Okeechobee Watershed and nonpoint source pollution loading associated with urban storm water runoff is not expected to increase significantly by 2050.

## **LAND USE - LAKE OKEECHOBEE REGION**

Lake Okeechobee has traditionally been a key source of water supply for irrigated crops around the lake including the EAA, the Caloosahatchee River Basin and Martin and

St. Lucie counties (Upper East Coast). Continued access to this source of water is considered vital to sustaining agriculture in the surrounding regions.

## **Agriculture**

The area is rural in character, with most lands dedicated to agriculture, very generally sugarcane is the predominant crop in the south, row crops and sugarcane in the east and pasture land with dairy production in the north. Urban areas, which are generally few and modest in population, service the agriculture sector, as well as the tourists who come to the lake to fish, hunt and enjoy other recreational pursuits.

## **Urban**

A significant use of land outside the agricultural context is for urban development. Six incorporated communities are situated around the lake and range in population from approximately 1,400 to 16,000.

The Brighton Seminole Indian Reservation occupies a large area of land west of the lake in Glades County. The southern end of this reservation is near the Herbert Hoover Dike just north of Lakeport.

Major transportation corridors around the perimeter of Lake Okeechobee include several highways and railroads. County Road 78 parallels the lake along its western and northern shores from Moore Haven to Okeechobee. From Okeechobee, State Highway 98/441 follows the northern and eastern portion of the lake to Pahokee. County Road 715 then follows the Herbert Hoover Dike from Pahokee to Belle Glade, where State Highway 27 follows the southern lake area back to Moore Haven and County Road 78. In many cases, these highways are within 1.6 kilometers (one mile) of the Herbert Hoover Dike, and are often within 15 meters (50 feet).

Railroad corridors in the Lake Okeechobee area include the Florida East Coast Railway and the South Central Florida Railroad. The East Coast Railway is located along the eastern part of the lake where it comes very near to the Herbert Hoover Dike. The South Central Florida Railroad travels along the southern end of the lake, where it comes within 1.6 kilometers (one mile) of the Herbert Hoover Dike.

## **ELIGIBLE COMPREHENSIVE EVERGLADES RESTORATION PLAN (CERP) PROJECTS**

### **Lake Okeechobee Watershed Project**

The Lake Okeechobee Watershed Project consists of four separable elements including: North of Lake Okeechobee Storage Reservoir, Taylor Creek/Nubbin Slough Storage and Treatment Area, Lake Okeechobee Watershed Water Quality Treatment Facilities and Lake Okeechobee Tributary Sediment Dredging. These components were

combined for an opportunity to generate a more efficient design of the components and address the interdependencies and trade-offs between the different components. More detailed information is available at [www.evergladesplan.org](http://www.evergladesplan.org).

